

Industrial Application of PLCs in Bangladesh

Ahmed Ullah Abu Saeed, Md. Al-Mamun and A.H.M. Zadidul Karim

Abstract— A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. The versatility and prospect of automation is so important that it could bring radical development in almost every aspect. In Bangladesh different types of industries concerning manufacturing, printing, food, plastics, leisure etc are already using PLCs and others to go. But the main problem lies in the dependency on the foreign consultants and engineers including reasonable amount of cost. In this case our effort on PLC would be a solution. The immediate objective of the thesis is to study and test the applicability of PLC in aspect of Bangladesh. To understand the necessity and application of PLC in industrial automation, a PLC based control system was applied in an automatic bottle filling station using LOGO! 230 RC. In the bottle filling system the PLC gets the sensor feedback and controls the solenoid valve timing as well as control the conveyer belt. It can fill two bottles with max height of 6.7" and max diameter of 4.7" in a minute. All the results lead to a conclusion that the potential of PLC in perspective of Bangladesh is very inspiring.

Index Terms— Automatic Bottle Filling Station, Conveyer belt, Industrial Automation, Ladder Diagram, LOGO! 230 RC, PLC, Sensor.

1 INTRODUCTION

Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the world economy and in daily experience [1]. PLC plays an important role in the world of automation industry. It acts a major function in the automation field. PLC has replaced the wiring and cabling system that were used in the previous. It's soft wiring feature makes changes in the control system easy and cheap. So in today's world it is very important to study PLC.

Most of the industries in Bangladesh now have started to employ PLCs. PLC reduces complexity, increases safety, cheap and PLC based automation system not only guarantees reduced production time but also a higher productivity both in terms of quantity and quality. For these reasons everyone is now willing to leave the conventional industrial control system and switch to PLC. PLC is being used in many sectors in Bangladesh. A few examples are - Manufacturing industries, travel industries, printing industries, food industries, hospitals, plastics industries, leisure (Roller coaster ride and effects control system) etc [2]. Also in some shops and restaurants many PLC based devices are being used. Even PLC is used in lift and escalator control systems. The application of PLC in many sectors of our country is increasing day by day.

The versatility and prospect of automation is so important that it could bring radical development in almost every aspect. And in case of automation PLC could be a vital tool. We have specially chosen the PLC based system and the goal is to study and test its applicability in aspect of Bangladesh. For this we have directly applied a PLC based control system in an automatic bottle filling station. In this paper we have addressed the design and implementation of a PLC based automatic bottle filling station. The whole paper is divided into several sections firstly this paper commences with a description of the product. Then it gives the design requirements and how the Programmable Logic Controller (PLC) was selected considering its features, others compromising factors and design requirements. This paper then gives functional description of the product. Finally, this paper describes advantages of the proposed device, limitations, result, conclusion and discussion.

2 ADVANTAGES OF PLC

1. High reliability
2. Small space requirements
3. Computing capabilities
4. Reduced costs
5. Ability to withstand harsh environments
6. Expandability
7. High power Handling
8. Reduce Human Efforts [3]

3 DESCRIPTION OF OUR PROPOSED DEVICE

It is a PLC based commercial kit. There are two parts of our device namely

3.1 Hardware Part

Our proposed device is consisted of a PLC (LOGO! 230 RC) [4], 24V DC Relay, 220V AC Relay, Sensor (PUYON KS-G22) [5], Solenoid valve, Single-phase induction motor, conveyer belt, 24 V DC Source, ON-OFF button and some connectors.

- Ahmed Ullah Abu Saeed is with the Department of Electrical and Electronic Engineering, University of Asia Pacific (www.uap-bd.edu), Dhanmondi, Dhaka-1209. Email: abusaeed_11@live.com.
- Md. Al-Mamun is with the Department of Electrical and Electronic Engineering, University of Asia Pacific (www.uap-bd.edu), Dhanmondi, Dhaka-1209. Email: almamuneee07@gmail.com
- A.H.M. Zadidul Karim is with the Department of Electrical and Electronic Engineering, University of Asia Pacific (www.uap-bd.edu), Dhanmondi, Dhaka-1209. Email: zadid_aust@yahoo.com

The ON-OFF button works as the input device. The PLC controls the input and output according to the program provided to it.

3.2 Software Part

There are five main programming languages for programmable control systems: function block diagram (FBD), ladder diagram (LD), structured text (ST; similar to the Pascal programming language), instruction list (IL; similar to assembly language) and sequential function chart (SFC). These techniques emphasize logical organization of operations. [6]

In our proposed device Ladder Diagram (LD) is used. The program is to interface the ON-OFF button and all the hardware parts with the PLC.

4 FLOWCHART DIAGRAM

Flowchart diagram of the working process of the proposed device:

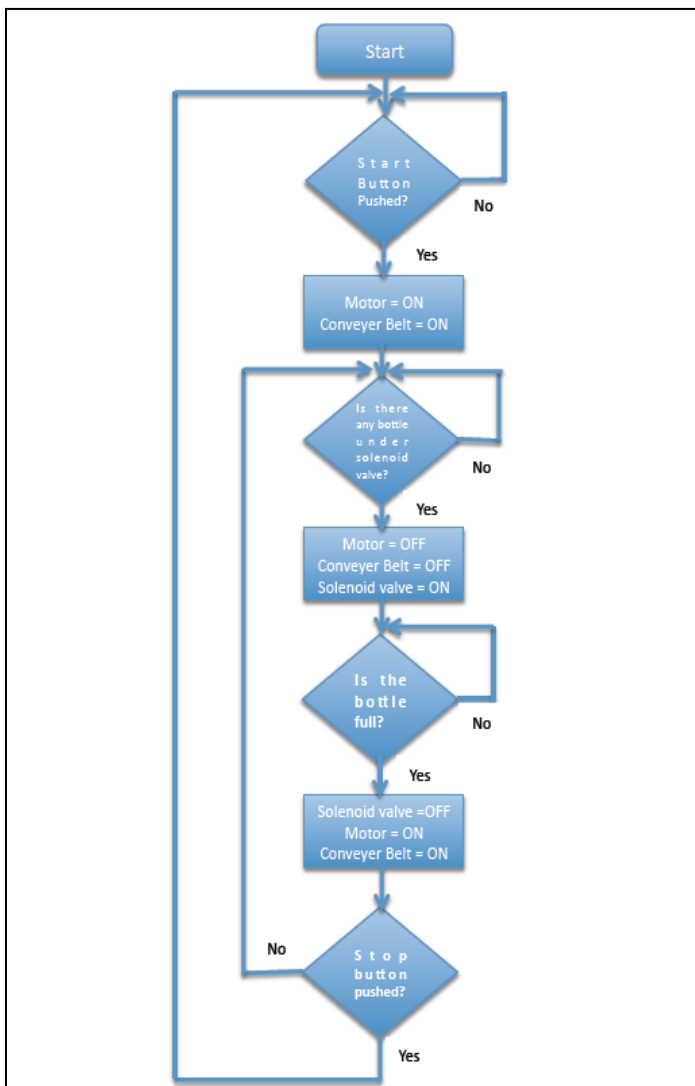


Fig. 1. Flowchart diagram of the working process of PLC based automatic bottle filling station.

When the start button is pushed the motor starts hence the conveyer belt starts moving. When the bottle is under the solenoid valve, the bottle is sensed and the motor hence the conveyer belt stops. Then the solenoid valve operates and the bottle starts filling with water. When the bottle is filled then the solenoid valve is closed and the motor hence the conveyer belt start moving and carrying the bottle away from the solenoid valve. If another bottle is sensed then the above process will be repeated. When stop button is pushed then the entire process will be stopped and reset the circuit.

5 SELECTION OF PLC

There are some main factors to choose a PLC for any application. They are:

- I/O
- Size of Memory
- Communications
- Compatibility to HMI
- Speed

Different PLCs have different number of I/O ports. And in some, adding external I/O cards can increase number of I/O ports. Memory Size is the memory amount available for the code of PLC. In some PLCs, adding external flash cards can increase memory size. Serial and networked connections allow the PLC to be programmed and talk to other PLCs. The needs are determined by the application. Human machine interface and it is a very important feature of PLC. Using this one can see the whole operation of the PLC program graphically. Speed is also an important factor in choosing PLCs. But Now-a-days PLCs are rapid enough for any kind of operation [7]. In the proposed device LOGO! 230 RC is used. In LOGO! 230 RC, there are 8 inputs and 4 relay type outputs. 4 ms full programs scan time and memory was more than enough for the automatic bottle filling station. That is why it is chosen.

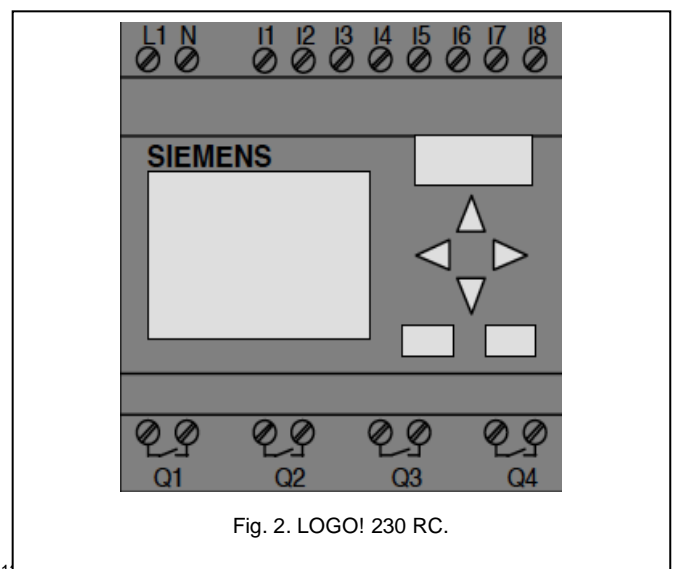


Fig. 2. LOGO! 230 RC.

6 PROTOTYPE DESIGN OF PLC BASED AUTOMATIC BOTTLE FILLING STATION

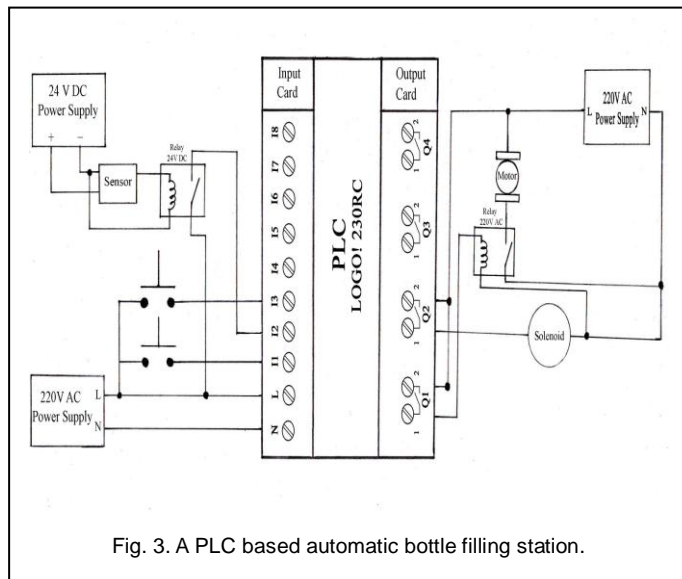


Fig. 3. A PLC based automatic bottle filling station.

The PLC is powered by a 220V AC power supply through its line (L) and Neutral (N) port. A Push button is connected from the same source to the input card terminal I1. A sensor is powered by a 24V DC power supply and its output is connected to a 24V DC Relay coil. I2 input of the PLC is connected to the NC terminal of the 24V DC relay. A 220V AC relay coil is connected with the PLC relay type output port Q1 and from the NC terminal of this relay the 1-phase motor of the conveyer belt is connected. A solenoid valve is directly connected with the PLC relay type output terminal Q2.

When the ON push button is pressed then the PLC input port I1 gets a pulse and for this the PLC relay type output Q1 is energized and the motor starts. Now when the sensor senses a bottle then it gives a pulse to the DC relay hence the DC relay operates. So the I2 input of the PLC gets a pulse and for this the relay type output Q1 is de-energizes and Q2 energizes according to the Ladder logic of the PLC. So the motor stops and the solenoid valve operates for certain period of time assigned in the Ladder logic of the PLC. After the assigned time PLC relay type output Q1 again energizes and Q2 de-energizes. So the motor again starts running and the solenoid valve becomes OFF.



Fig. 4. Practical view of our proposed device.

7 SYSTEM SPECIFICATION

1. Input: 220 V AC
2. Capacity: 2 BPM
3. Maximum bottle height: 6.7''
4. Maximum bottle diameter: 4.7''
5. Maximum pressure: 1 bar
6. 1 filling Nozzle
7. Automatic shut off when bottle is full
8. Best liquide: Water

8 LIMITATION

It can only fill approximately two bottles per minute, which is a little bit slow. The process can be efficiently used in water filling system. The types of fluid to be handled is mainly dictated by solenoid valve and nozzle used. So the range of fluid types is not so wide. Positioning of the solenoid valve is a critical issue and proper care needed. Another disadvantage is that there is no guide way for the bottles making the system susceptible to imbalance vibration. This system is constrained by height (max 6.7'' inch) of the bottle of a specific volume.

9 RESULTS

The device can fill up 2 bottles of maximum height of 6.7'' and maximum bottle diameter of 4.7'' in 1 minute at 1 bar pressure. So it can be used commercially in various coffee shops, juice shops, cold drink shops etc and reduce human effort. So the practical research result is very much satisfactory. It also helps to understand the necessity of PLC in industrial automation and also to realize the necessity of studying it.

10 FUTURE WORK

Using appropriate pump, jet nozzle and strong solenoid valve in which case precise timing would be needed can increase productivity. A guide way could be used in case of vibration. A non-intrusive water level sensor could be used instead of depending on the valve timing. An extended capping section could also be introduced. Another sensor could be used in the beginning, which can sense the bottle and start the conveyer belt automatically. More flexibility can be introduced in nozzle positioning. The system could be redesigned for increased bottle size and productivity.

11 CONCLUSION

Automation increases productivity, which in turn brings economic progress. The role of PLC in automation is basically controlling the whole system. The installation cost is not so cheap but in the long run the reliability and performance of the system makes up to the investment [1].

In Bangladesh different types of industries concerning manufacturing, printing, food, plastics, leisure etc are already using PLCs and others to go. But the main problem lies in the dependency on the foreign consultants and engineers including reasonable amount of cost. In this case our effort on PLC would be a solution.

The PLC based control system has been studied along with its prospects in this paper. A PLC based control system was applied to the automatic bottle filling station previously specified and the performance was measured. All the results lead to a conclusion that the potential of PLC in perspective of Bangladesh is very inspiring.

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Ahmed Ullah Abu Saeed has completed B.Sc. Engg. (EEE) in the Department of Electrical and Electronic Engineering (EEE), University Of Asia Pacific (UAP). Now he is working as an Engineer in Baneco Solar Energy Ltd

(www.banecosolarenergy.com).



Md. Al-Mamun has completed B.Sc. Engg. (EEE) in the Department of Electrical and Electronic Engineering (EEE), University Of Asia Pacific (UAP).



A.H.M Zaididul Karim has been serving as an Assistant professor in the Department of Electrical and Electronic (EEE) Department, University of Asia Pacific (UAP). He joined at UAP in April 2007 after completion of his BSc. Engg. (EEE). He has completed his MEngg. from BUET. Right now he teaches courses on Digital Electronics, Digital signal processing (DSP), Electrical Machines, Electrical and Electronics Circuits. Besides this, he is a convener of EEE Sports Club.